

HCID: Who is an interaction designer?

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Abstract: *The development of technology with all its ubiquity and pervasiveness provides new opportunities and new challenges for the interaction design practitioners, both those coming from the design tradition and computer science tradition. An increased level of problem solving and creative thinking is needed when designing for interactions with new technology. In order to develop the skills and methods for dealing with increased complexity and connectedness of technology, human computer interaction design (HCID) education needs to embrace to a larger extent design practices and design thinking. This paper aims to answer two main questions: 1) why is it necessary to teach HCID students design thinking skills and 2) how to actually implement the changes in HCID curriculum. The second question is answered based on our experience and the solution we adopted. Subsequently, we discuss the success of our approach.*

Keywords: *HCID, interaction design, education, design thinking, project-based learning, practice, cool, possibility design.*

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Introduction

Just days ago we returned from a major human-computer interaction (HCI) conference. Good atmosphere, good papers. During presentations, we all refer to ourselves as interaction designers. During breaks, while chatting with newly acquainted colleagues, we ask each other: “What is your background?” This question reveals that there is a multitude of ways to become an interaction designer and acknowledges us all as such. Yet, the kind of education one received still implicitly defines what we are according to the “old” classification by discipline: a computer scientist, a psychologist, an industrial designer, an artist, an engineer or an architect. Owen (Owen 2007) further simplifies this classification into “finders” and “makers”, essentially scholars, working through understanding (science thinking) and those who synthesise their knowledge into new constructs, patterns, concepts etc., building our living environment in the process (design thinking, see (Brown 2008)).

While this view may be useful in explaining design thinking, it may not be equally helpful with interaction design (ID) as a discipline. We believe that interaction design may be positioned as shown in Figure 1. A few interaction designers may view their work as science thinking only; some may view it as predominantly design thinking, but the majority of interaction designers do both to varying, but substantial, degrees and proportions.

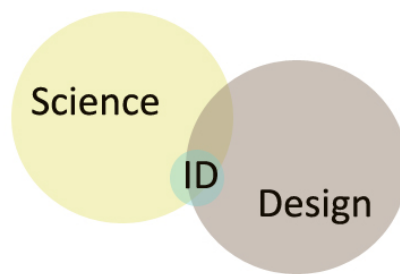


Figure 1. Interaction design is a multidisciplinary field, placed between science and design.

This paper contains some reflections by a group of interaction design practitioners and students upon the above classifications from the perspective of science and design thinking simultaneously. Our education could be classified as that of “finders” as we all have computer science background. Within the computer science department, we are occupied with design, use, and interaction with technology. In this paper, we argue that we actually belong in the ID circle as shown in Figure 1. However, we do not have any formal classes in design thinking, form or materiality. We do have extensive course work in HCI or rather what is sometimes referred to as Human-Computer Interaction Design HCID (Faiola 2009), perhaps to make it distinct from interaction design at institutions such as design schools, schools of architecture or art. We will showcase our design practice through some student and research projects. We aim at making a case for HCID education within university settings that is closer to that of studio design practices. We also hope to show that our education is getting closer to meeting that goal. It remains to be seen whether the question about the background will eventually become less important and that the kind of work we do will become the determining factor in the “new” classification by our practice.

The paper is structured as follows: in the next section we establish a framework for the discussion of our approach by describing some trends in the field and providing a framework for further discussion, both in terms of where research in the field is, and where education is, making a point that there is a gap between the two. Thereafter, we provide some examples of how we work and what we learn through student projects, research projects, master theses and exhibit design. These examples aim to show that interaction design for us embraces experience design, emotional design etc., and is also concerned with the form of tangibles (with design of the tangible technological products). Discussion whether this is a “finder”, a “maker” or an education that is both of these, is followed by a conclusion and future work.

HCID and design: research and educational gaps

Human-computer interaction (HCI) emerged from computer science as a new area of research and practice in the early 1980s. Over the course of the past 30 years, HCI has evolved as a field. From the first wave of HCI often described as an era of usability testing in 80's, through the second wave with the “human” in the center, HCI is currently in its third wave with experience, emotion and context in focus (Bødker 2006). There is more talk about socio-materiality, phenomenology, design thinking, dialog etc. and much less talk about the design-as-engineering approach from earlier waves of HCI. The name widely used for the discipline today is not the third wave HCI, but rather HCID or simply interaction design. The latter will be used interchangeably with HCID throughout this paper. The “interaction design” also indicates the change in technology: it is no longer interaction with computers that is central, but rather interaction with ubiquitous and pervasive digital objects or emerging areas such as cultural computing, technology supported co-creativity etc. The major conference in the field, CHI, has added cultural computing and digital arts to the set of its focus domains and the audience at the conference is more diverse than ever.

The interaction design practice is undergoing enormous changes. This is largely brought about by fast and vast technology development. When designing for interaction with new technology, we need to understand emerging interaction design practices and digital materiality. Based on those understandings, we need to offer new theories, models and frameworks that will better suit future researchers and practitioners of interaction design. This, naturally, also implies changes in educational content and style.

Goodman, Stolterman and Wakkary advocate designerly practices that are resonant with everyday work of interaction designers:

We believe that empirically grounded descriptions and critical analyses of design practice activities will offer frameworks for reflection on practices that designers can find useful. Such a research enterprise could then help create opportunities for HCI researchers to build long-term engagements with design practice that make sense to practitioners. (Goodman 2011, p. 2)

Many attempts have been made to bridge the diversity of practices within the field. Some notable ones are HCI design as radically interdisciplinary dialogue (Wright 2006), convergent - divergent questioning (Dym 2005), models, theories and frameworks toward a multidisciplinary science (Carrol 2003), and research by design, see (Forlizzi 2008; Fallman 2003; Zimmerman 2007; Zimmerman 2010).

Our theoretical position is influenced by that of Klemmer, Hartmann and Takayama:

Our physical bodies play a central role in shaping human experience in the world, understanding of the world, and interactions in the world. ... We introduce aspects of human embodied engagement in the world with the goal of inspiring new interaction design approaches and evaluations that better integrate physical and computational worlds. (Klemmer 2006, p. 1)

Our bodies are indeed the ultimate instruments for collecting knowledge. We experience the world through our senses; we interact with it using those senses. We also learn by doing (Piaget 1952). For interaction designers, it also makes sense to talk about thinking through doing (Klemmer 2006).

Many have expressed their opinions based on the nature of design practices that HCID should be a design discipline.

Subject disciplines like sociology, psychology and English literature may offer the best grounding in understanding the human in human computer interaction, and craft disciplines together with engineering science and visual and performance arts may offer the best grounding in designing and building interactive environments, products and services. (Wright 2006, p. 13)

However, designers need to understand both opportunities and challenges that various kinds of technology provide. Pervasive and ubiquitous technology is permeating physical objects around us and offering new experiences and interaction modes, from interacting with touch surfaces to radical atoms. The kind of knowledge required is more complex than the eternal question designers so often ask: should designers need to know how to program?

Many design schools have begun to introduce courses on computation to prepare students for these new challenges. These approaches are usually based on adapting and simplifying courses developed in computer science schools, such as teaching students the basics of programming, or introducing the general principles of a particular computing technology. ... Such approaches do not recognize that two radically different education models need to be bridged. Design and craft schools generally follow the experiential learning paradigm, in which knowledge is acquired mainly through doing and working on practical projects. Computer science education, on the other hand, has its roots in mathematics, often emphasizing formal methods and models, articulation of general principles, and a top-down approach to problem solving. (Obrenović 2012, p. 1)

Obrenović continues towards offering a model for experiential teaching of advanced computational concepts and techniques for design students.

Our point of view is that somebody trained as a computer scientist may also learn the design thinking and design oriented practices in order to work with, and make, better physical products with embedded technology. Agreeably, this may not always be easy, as the following anecdote illustrates vividly: students in a HCID class were given the assignment to do observations of the use of technology at a place of their choice. Somewhere in the assignment text, they were also asked to draw the place of the observation. Several students delivered the assignment without a drawing of the site, and one student wrote, obviously disturbed: "We were not told that drawing skills are required in order to take this class." However, those students that do decide to continue with graduate education in interaction design are also ready to accept more design-oriented practices in their work.

A more constructivist learning practices for early learners may change the above attitude and help youngsters, and eventually the rest of us, feel more at ease with traditional design tools such as drawing (MindShift 2012). The physical space, flexible and creative, such as the school in Figure 2, offers support in that direction. This is not a trivial aspect of the problem we are discussing, as traditionally, computer science educational programs, including HCID, are taking place in traditionally looking classrooms, which are not fostering the kind of exchange that studio-based practices do.



Figure 2. Multiple usage environment supporting creative learning practices. Vittra School, design Rosan Bosch Studio. "The Mountain" is the central point of the school. Photo: Kim Wendt.

In their paper on creativity in computer science Cennamo et al. discuss and compare the creative practices in industrial design, architecture and HCID (Cennamo 2011). Several disciplines within computer science, such as HCID, graphics and visual programming, information design and information visualization, may be substantially supported by learning about design and design thinking. When presented with problems to solve, both industrial design and architecture students focused on experimentation, while HCI students focused primarily on idea refinement. The authors state:

Although we need software designers who can follow rules when presented with technical and rational problems, we also need designers who can make good sense out of those problems that are not technical or rational: that is, designers who are aware of multiple possibilities for solutions, who can make good choices, and who can reflect on the choices they make to determine if their goals have been met. (Cennamo 2011, p. 1)

Buxter implies that various skills will be necessary to tackle problems: "We need coverage of the larger skill set distributed among a heterogeneous team, not the individual" and follows with "for that team to function well, the players must have at least a basic literacy in each other's specialties, if not a high level of competence" (Buxter 2007, p. 230).

Fry (Fry 2006) reflects upon this and concludes that in order to avoid collaborative difficulties within multidisciplinary teams, computer science, or at least HCID, needs to introduce creative design skills and knowledge as part of their education.

In her article advocating a new paradigm for design education, Wang sees a potential for great synergy between design and HCI educations and states:

The possible new paradigm offered by complexity theory not only promises to make pedagogical methodology of design studio education more academically respectable, but it also promises to provide a new model of understanding how HCI can become indispensable to design education. (Wang 2010, p. 8)

We do not find much evidence in literature as to how, even when the need is clearly identified, education in computer science, and in particular HCID, implements design thinking and design oriented practices into curriculum. The next section shows our approach.

How to include design practices in HCID education

We present two examples illustrating our approach prior to discussing both why and how design oriented practices could become a part of the HCID curriculum. The first example shows how research projects can be transformed into project-based teaching which includes the design thinking. The second example shows how introducing design thinking cognitively, through published works and lectures, may lead students towards better understanding of what design thinking is. Consequently, it seems to be easier for students to apply it in their work and projects. The first approach is used in an undergraduate course and the second in a graduate course.

The case of designing for a children's museum using research and project-based teaching

Six years ago one of the authors of this paper participated in making of the master plan for a large children's museum in Oslo. An international, multidisciplinary design team carried out the design process. The team included interaction designers from both design and HCID communities. When the funding for the project became a problem, the research through design enabled at least parts of the project to be realised. The project was by its nature a perfect platform for research on embodied interaction, hands-on, touch and experience interaction styles, including whole body interactions. For the past five years, the undergraduate course in interaction design has been used in order to design and build functional prototypes of the exhibits for the museum. A total of thirty-eight student projects were carried out in this context. As researchers, we have experimented with ways to engage children in the design process. A mobile children's museum was born and is operational on a small scale, visiting local schools and kinder gardens, and providing children with possibility to participate in the museum design process.

Student groups working on children's museum projects have used design approaches ranging from genius design to participatory design, and have always involved children in roles of users and testers in their design processes. On occasion, the children were involved to a much larger degree, contributing to the process as informants to design or even design partners (see (Druin 2003) for the roles of children in the design of technology).

The students have learned by doing, by making tools for creative engagement of participating children and identifying a wider range of design possibilities. By thinking through doing, sometimes seemingly repetitively, we have gained a deeper understanding of how to work with children, how to involve them in the design process most effectively, and how to give them influence and power in participatory design settings when they are unable to represent their views adequately (Culén 2012; Culén 2013). Working in this way, the interaction design students certainly got a taste of design practices. In addition, they were required to be able to reflect upon what they do, to be “reflective practitioners” (Schön 1983) and deliver reports on their design process.

The design process in these efforts could be described as shown in Figure 3. Clearly, there are still iterative cycles present. However, at the start, there are also explorative workshops with the design team and an explorative workshop with the target group, in this case young children. The process embodies both “finder” and “maker” approaches.

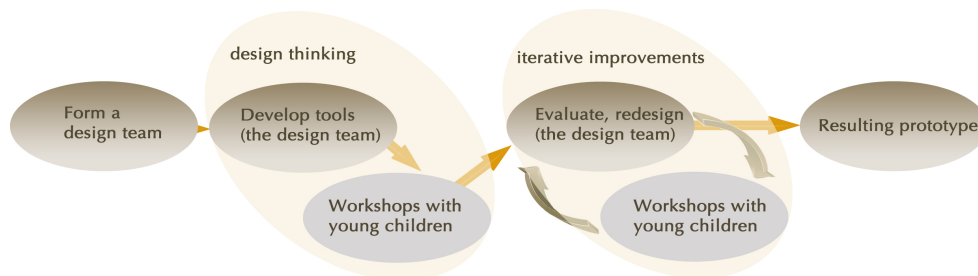


Figure 3. The design process followed by design teams, employing both “maker” and “finder” approaches.

Figure 4 and Figure 5 show some examples of prototypes made by students. The prototypes are rough, but clearly showing interaction modes and functionality. We argue that this is part of the HCID value system: when things function well, are made simple and enables the person participating in the interaction to have a sense of joy, this approaches the experience of aesthetics or beauty. A more traditional approach to the form and materiality is considered, but the time frame for the projects is short and thus getting a working prototype is more valued than obtaining a more “finished” look. The students do have a studio, or rather a lab as we call it, at their disposal (see Figure 7). They work in groups of 3-5 students per project. Almost all projects employ paper prototyping sessions, some generative tools, brainstorming, mind mapping, user observations and contextual inquiry. Sketching, story boarding, making of personas and scenarios are also often used. Alternative approaches to problem solving are always considered (and are a required part of the course, as is the decision making process). In this first phase of the process, the approach is very much designerly. Once a choice is made, most groups switch to a high fidelity prototype making and iterative improvements until the product does what the interaction design students intended it to do.

The project-based teachings coupled with genuine research interests, the aspects of which may be defined as design briefs involving some form of technology, have given very good results with HCID students. Both the faculty and students feel positive to this

way of working and we feel that we are getting better at it, i.e. we truly are both learning and thinking through doing.

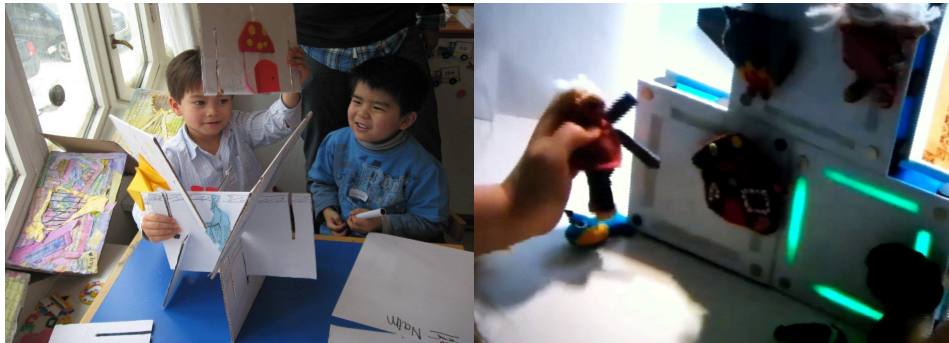


Figure 4. Making 3D books with children (left), and an early technological prototype (right).



Figure 5. These pictures were taken during the exam in the class and show two different projects: model of the tangible solar system (left) and, for the youngest children, what octopus eats (right). Note that the adults need to bend down; the models are scaled down to a child of 2 - 4 years.

The case of the exhibit design, a graduate course project

The graduate course in interaction design introduced the students to design thinking concepts through in class discussions of articles such as (Fogg 2009; Fallman 2003; Höök 2012; Desmet 2012; Holtzblatt 2012). The class project for the semester was a co-arrangement of a UX exhibition where students were entirely free to select the exhibits. Here is how one of the participants described the project:

We wanted to showcase some experience design items. It turned out that there were implicit adjectives that I myself had not thought about before; in my head a user experience, when designed properly, is always a positive one. There were several other adjectives, such as “novelty” and “breadth”. The user experience should be more than novel, it should be cool, and, if possible, should broaden people’s view of what UX is.

The students involved in this project were paired up and encouraged to consider several different perspectives when thinking about the exhibit. These perspectives included the architectural lens, the cognitive lens, emotional lens, ludic etc. One of the goals was to consider the visitor’s experience from before they walk into the building, until they are long back into their everyday lives. To design for from the moment the first social media or other announcement about the exhibit is given to a visitor. They should also have something that can bring back the memories of the exhibit any time. The design process though quickly changed from a goal and problem oriented process to a possibility driven design process (Desmet 2012). This is how the class described this process, as part of their reflexive statement:

The problem driven process would have stopped at merely designing a user experience. We had a couple of ideas, ideas that would definitely have solved the problem phase and created a novel user experience - we discarded those in favour of fewer experiences that were simply guided by a desire to make people happy at the moment, by providing cool and new hands on exhibits.

The design process started with a brainstorming session and followed the process of inspiration, ideation and implementation (Brown 2008). We discarded the ideas that were not feasible or not interesting and left around 10 concepts to continue working with. During the brainstorming session, a suggestion was made to select based on how “cool” the concept is. Cool is a recent topic in the HCI community, see (Holtzblatt 2012; Culén 2012). Thus, the 10 concepts were all having a “wow” factor for us and they were all feasible within the given time frame. The final selection that was consequently implemented consisted of an augmented reality weather window (using iPads), privacy screens (using polarized glasses), artsy colourful QR-codes and brain-computer interface (BCI) which we used to control toy trains.

In the prototyping process we used all the tools we could place our hands on. We created the privacy screen using old discarded LCD-monitors, by taking the screens apart and removing the built in polarized filters as shown in Figure 6. We experimented with different materials for the polarized glasses, both for the filter that actually filtered the light and for the frame. The first iteration was to print our cool design on a 3D printer, but settled on modifying existing 3D cinema glasses frames for the project as shown in Figure 7.

The BCI-controlled train concept started out with brainstorming around what could be done with it that is cool and nobody has seen yet. To move something physical, using thoughts only, sounded cool. Cars, trains, planes, helicopters were all possibilities to consider. The choice fell on a train. We bought a basic train-set and decided to control it using Arduino and a motor shield.

Once the BCI unit was connected to the train and it was every bit as cool to control it as we hoped it would be, we decided that we should have two sets so that people could compete against one and another.

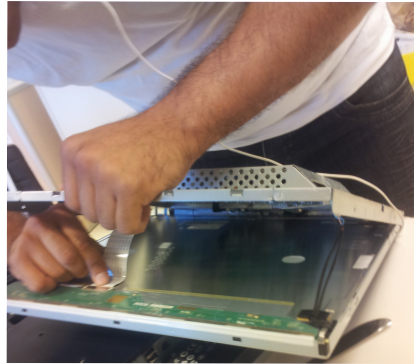


Figure 6. Re-using material. Old screens are being modified so that they can show the information in new ways – through privacy glasses.



Figure 7. Making polarized glasses in order to display some interesting documents with “secrets”.

However, it was not until the reflection process that the students came to realize that the process had been a combination of both design thinking and HCID. They could not categorize the process as either “finder” or “maker”, but only somewhere in between and there was a unanimous consent that using only one of the two approaches could not have led to the eventual success of the exhibition.

The conclusion from the reflection process amongst the students was that the design is in fact all about practice, not about background. Despite their computer science background they participated in arranging and successfully carrying out an exhibition using a combination of design thinking and HCID practice. Their background is still from computer science, but by expanding the traditional design process from HCID with design thinking, they have experienced designing with technology in a new way and with a new awareness of the process.

Discussion

Based on our experience from both graduate and undergraduate courses in HCID, we can only argue in favor of continuing to combine the practices from design and HCID disciplines. The “finders” approach can be successfully supplemented with a “makers” approach and design thinking in order to enrich the design process and allow students to solve problems in new ways that have previously not been thoroughly explored within the HCID community. We thus strongly advocate expansion of our HCID curriculum with design thinking and practices and development of a strong multi-disciplinary competence. Most interaction design projects are carried out today in a framework of multidisciplinary teams and there are compulsive reasons for the education to support the students in being able to work in such teams effectively.

The way students used to approach the design of technological solutions or products in traditional HCID often limited the creative space by choosing a viable solution prematurely, without real exploration of alternatives. Using the design thinking and designerly practices makes the initial processes more free and allows the students to properly explore the ideas and concepts with a more hands-on approach.

As mentioned, our students have worked with all sorts of design methods, from genius design, user centered design, or co-design to participatory design, involving the users to a varying degree in the design process. We find that the design thinking may be successfully applied in conjunction with a whole range of methods and techniques within HCID, regardless of the level of user involvement.

These are not revolutionary findings, they are fully in line with work of Winograd, Mathiassen, Nelson, Löwgren and Stolterman (Winograd 1996; Mathiassen 1999; Nelson 2003; Löwgren 2004) among others. Their work and reflections answer the question *why should design thinking be part of information technology* from different perspectives.

We would like to join in and say yes, design thinking should be part of the HCID student’s education. We find that, in our context, the learning process becomes more hands on and embodied. In addition, we can observe that the quality of student’s work is improved. Finally, we note that the HCID students will not become designers by having design thinking as part of their education. They will be simply better equipped for working in multidisciplinary teams. Their personal contribution is stronger, the communication barrier is lower and their joy in the process is higher. We agree with:

Design competence allows individuals to become causal agents of the real world. This competence is an embodiment of the foundations and fundamentals presented in this book and subsequently acted upon with the values and principles of a design culture. Anyone who so chooses can become design competent. (Nelson 2003, p.301)

When trying to answer how the design practices and design thinking could be integrated with HCID practice, we believe that we have found a good way of engaging the students. Our exhibit design example is a good example of how the integration of design thinking has helped us achieve the desired effect. The exhibit was regarded as very cool, not only by us, but by our visitors as well. Our visitors included students, faculty, research collaborators and representatives from the industry. We especially believe the inspiring effect the exhibition had on the students further demonstrates why the HCID discipline needs to learn from design thinking.

Conclusion

Based on the results our students achieved after being introduced to design thinking, we can conclude that for students in “finder” schools, a competence in “making” makes them both better finders and makers. Their work becomes better, and their thinking broader. Their confidence in their understanding as well as being able to contribute to the process gives them a better basis for being successful as members of multidisciplinary teams.

Our examples show how we integrated design thinking with HCID both at undergraduate and graduate level. At undergraduate level we use hands-on approach, but base the student projects on real research projects or industry cases. At the graduate level, a cognitive approach is used at the start, followed by a design project and finally, a reflection. In both cases, students achieve deeper levels of understanding of what design is and how they can apply this new knowledge and skills in their work and in their lives.

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References

- Bannon, Liam. 2011. “Reimagining HCI”, *Interactions*, 50–57.
- Buxton, Bill. 2007. *Sketching User Experiences*. San Francisco: Morgan Kaufmann, 2007.
- Binder, Thomas, Giorgio De Michelis, Pelle Ehn, Giulio Jacucci, and Per Linde. 2011. *Design Things*. MIT Press.
- Björgvinsson, Erling, Pelle Ehn, and Per-Anders Hillgren. 2012. “Design Things and Design Thinking: Contemporary Participatory Design Challenges”. *Design Issues* 28(3): 101–116. doi: 10.1162/DESI_a_00165.
- Bødker, Susanne. 2006. “When Second Wave HCI Meets Third Wave Challenges”, in *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles*, NordiCHI '06 (New York, NY, USA: ACM, 1–8. doi:10.1145/1182475.1182476
- Brown, Tim, and others. 2008. “Design Thinking”, *Harvard business review*, 86, 84.
- Carroll, John M. 2003. *Hci Models, Theories, and Frameworks: Toward a Multidisciplinary Science*. Morgan Kaufmann.
- Culén, Alma Leora, and Andrea Gasparini. 2012. “Situating Techno-Cools: Factors That Contribute to Making Technology Cool and the Study Case of iPad in Education.” *PsycNology Journal* 10 (2): 117–139.
- Culén, Alma Leora. 2012. Transforming Children’s Museums by Designing Exhibits with Children, Transforming Museums DREAM International Conference, May 23-25, 2012 Roskilde DK.
- Culén, Alma Leora, Maja van der Velden, and Anna Karpova. 2013. Challenges in Designing for and with Vulnerable Children and Teens. In evaluation process, workshop on design for and with vulnerable users, CHI 2013, Paris.
- Cennamo, Katherine, Sarah A. Douglas, Mitzi Vernon, Carol Brandt, Brigitte Scott, Yolanda Reimer, and others, ‘Promoting Creativity in the Computer Science Design Studio’, in *Proceedings of the 42nd ACM technical symposium on Computer science*

- education, SIGCSE '11 (New York, NY, USA: ACM, 2011), pp. 649–654
<doi:10.1145/1953163.1953344>
- Desmet, Pieter, and Marc Hassenzahl. 2012. "Towards Happiness: Possibility-Driven Design." In *Human-Computer Interaction: The Agency Perspective*, ed. Marielba Zacarias and José Valente Oliveira, 396:3–27. Berlin, Heidelberg: Springer Berlin Heidelberg. http://link.springer.com/chapter/10.1007/978-3-642-25691-2_1?
- Druin, Alison. 2002. "The Role of Children in the Design of New Technology". *Behaviour and Information Technology*, 21, 1, 1-25.
- Dym, Clive, Alice Agogino, Ozgur Eris, Daniel Frey, and Larry Leifer. 2005. "Engineering Design Thinking, Teaching, and Learning", [cited 21 October 2012]. http://digitalcommons.olin.edu/mech_eng_pub/22.
- Faiola, Anthony. 2007. "The Design Enterprise: Rethinking the HCI Education Paradigm", *Design Issues*, 23, 30–45.
- Faiola, Anthony, and Sorin A. Matei. 2010. "Enhancing Human–computer Interaction Design Education: Teaching Affordance Design for Emerging Mobile Devices", *International Journal of Technology and Design Education*, 20, 239–254.
- Fallman, Daniel, 2003. "Design-oriented Human-computer Interaction", in *Proceedings of the SIGCHI conference on Human factors in computing systems*, 225–232. <http://dl.acm.org/citation.cfm?id=642652>
- Fogg, B. 2009. Creating persuasive technologies: an eight-step design process. *Proceedings of the 4th International Conference on Persuasive Technology*, ACM 44:1–44:6.
- Forlizzi, Jodi, John Zimmerman, and Shelley Evenson. 2008. "Crafting a Place for Interaction Design Research in HCI", *Design Issues*, 24, 19–29.
- Fry, Richard. 2006. "Defining the Obvious: Explaining Creativity and Design Thinking to Nondesigners". Accessed on October 27. 2012 from <http://www.divergedesign.com/ResourcesUser/Documents/how/ExplainingCreativityanddesignthinkingtoNondesigners.pdf>
- Goodman, Elizabeth, Erik Stolterman, and Ron Wakkary. 2011. "Understanding Interaction Design Practices", in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '11 (New York, NY, USA: ACM, 2011), 1061–1070. doi:10.1145/1978942.1979100.
- Holtzblatt, Karen. 2011. "What Makes Things Cool?: Intentional Design for Innovation." *Interactions* 18 (6) (November): 40–47. doi:10.1145/2029976.2029988.
- Höök, Kristina. 2012. Affective Computing. *The Interaction Design Foundation*. [/encyclopedia/affective_computing.html](http://encyclopedia/affective_computing.html).
- Klemmer, Scott R., Bjorn Hartmann, and Leila Takayama. 2006. "How Bodies Matter: Five Themes for Interaction Design", *Proceedings of the 6th conference on Designing Interactive systems*, 140–149.
- Mathiassen, Lars and Jan Stage. 1999. Informatics as a multi-disciplinary education. *Scandinavian Journal of Information Systems* 11, 2, 13–22.
- MindShift . 2012. *Why Learning Should Be Messy* [cited 21 October 2012]. <http://blogs.kqed.org/mindshift/2012/10/why-learning-should-be-messy>.
- Nelson, Harold and Erik Stolterman. 2003. *The Design Way: Intentional Change in an Unpredictable World: Foundations and Fundamentals of Design Competence*. Educational Technology.
- Owen, Charles. 2007. "Design Thinking: Notes on Its Nature and Use", *Design Research Quarterly*, 2 (2007), 16–27.
- Piaget, Jean. 1952. *The origins of intelligence in children*. International University Press.

- Schön, Donald. 1983. *The Reflective Practitioner, How Professionals Think In Action*, Basic Books.
- Löwgren, J. and Erik Stolterman. *Thoughtful Interaction Design: A Design Perspective On Information Technology*. MIT Press, 2004.
- Tse, Edward, Johannes Schöning, Yvonne Rogers, Chia Shen, and Gerald Morrison. 2010. "Next Generation of HCI and Education: Workshop on UI Technologies and Educational Pedagogy", in *CHI '10 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '10, New York, NY, USA: ACM, 4509–4512 doi:10.1145/1753846.1754186
- Wang, Tsungjuang. 2010. "A New Paradigm for Design Studio Education", *International Journal of Art & Design Education*, 29 (2010), 173–183. doi:10.1111/j.1476-8070.2010.01647.
- Winograd, Terry. 1996. *Bringing Design to Software*. ACM Press.
- Wright, Peter, Mark Blythe, and John McCarthy, 2006. "User Experience and the Idea of Design in HCI", *Interactive Systems. Design, Specification, and Verification*, 1–14.
- Zimmerman, John, Jodi Forlizzi, and Shelley Evenson. 2007. "Research Through Design as a Method for Interaction Design Research in HCI", in *Proceedings of the SIGCHI conference on Human factors in computing systems*, 493–502. <http://dl.acm.org/citation.cfm?id=1240704>.
- Zimmerman, John, Erik Stolterman, and Jodi Forlizzi. 2010. "An Analysis and Critique of Research Through Design: Towards a Formalization of a Research Approach", in *Proceedings of the 8th ACM Conference on Designing Interactive Systems*, 310–319. <http://dl.acm.org/citation.cfm?id=1858228>.